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PENSOFT

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Discovery of the Old World genus *Rogas* Nees (Hymenoptera, Braconidae, Rogadinae) in the New World by DNA barcoding

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Abstract

Morphological taxonomy and a molecular phylogenetic analysis led to the recognition of a new species of *Rogas* Nees from Costa Rica, *R. shimborii* Quicke & Sharkey, **sp. nov.** This represents the first discovery of the genus from the Americas; all previous records being the results of misidentifications and alternative interpretations. The new species is illustrated photographically, a minimalist diagnosis based on the COI DNA barcode is provided, supplemented by morphological and color diagnostic features.

Key Words

Distribution, Malaise traps, new species, parasitoid wasps, systematics, *Triraphis*

Introduction

Historically there has been much confusion about the identity of the rogadine braconid genus *Rogas* Nees, 1819 and several authors (e.g. Marsh 1979) combined it with the far commoner genus *Aleiodes* Wesmael, 1838 as well as with *Triraphis* Ruthe, 1855; therefore for much of the 20th century *Rogas* was widely treated as a massive "dumping ground" for a majority of rogadine species. Although many species of New World Rogadinae have been referred to in the past under the generic name *Rogas* (or its invalid emendation *Rhogas*), (e.g. Marsh et al. 1979, Shaw 1997), nearly all of these have subsequently been transferred either to *Aleiodes* or to *Triraphis* Ruthe, leaving typical *Rogas* interpreted as small and (up to now) an entirely Old World genus (Shaw et al. 1998; Valerio 2006; Gates et al. 2012; Shimbori and Martínez 2016; Broad 2021). In fact, *Aleiodes* and *Rogas* are not closely related and belong to different, well-separated, tribes (Jasso-Martínez et al. 2020; Quicke et al. 2021; Shimbori et al. 2024).

Shenefelt (1975) treated *Triraphis* as a junior synonym of *Rogas*, however, van Achterberg (1991), resurrected *Triraphis* and included three species: the western Palaearctic *T. tricolor* (Wesmael 1838), the type-species, and two north American species, *T. harrisinae* (Ashmead, 1889), and *T. discoideus* (Cresson 1869). Subsequently, a number of Costa Rican *Triraphis* species have been described and named including 13 new species by Valerio and Shaw (2015) and 30 new species by Sharkey et al. (2021). However, the anticipated number from Costa Rica alone based on extensive collecting, rearing and barcoding there, greatly exceeds the current total. Morphologically, *Triraphis* differs from those of *Rogas* mainly by the shape of the basal lobe of the claw, and in the ventral part of the occipital carina.

During preparation of a new key to a New World genera of Rogadinae, (Sharkey et al., in prep.) two Costa Rican specimens originally identified as members of *Triraphis*, were recovered in a neighbor-joining tree based on DNA barcodes, remote from other members of the genus.

Zaldivar-Riveron et al. (2004) noted that New World '*Rogas*' species exhibit a unique venom apparatus and commented that they may not be closely related to the Old World ones. The situation was clarified by the publica-

tion of van Achterberg's key to the Afrotropical genera of Rogadinae which included a redescription of *Rogas* and presented a key that separated *Rogas* from other genera of Rogadini including *Triraphis* (van Achterberg, 1991).

Materials and methods

Morphological terminology follows van Achterberg (1988) except for wing venation which follows Sharkey and Wharton (1997) (see also figures in Quicke (2015) and Sharkey et al. (2023)).

Collection acronym for specimen deposition

CNC Canadian National Collection of Insects, Arachnids and Nematodes, Ottawa, Canada

Molecular and phylogenetic methods

We conducted a phylogenetic analysis with the barcoding region of cytochrome oxidase *c* subunit 1 (COI; Hebert et al. 2003) and the D2–D3 expansion region of 28S rDNA (28S). We included the most complete DNA sequences for every species of Rogadini for which a barcode BIN was available (Ratnasingham and Hebert 2013).

Alignment of COI was trivial as there were no indels. The length-variable 28S sequences were aligned according to the secondary structure model of Gillespie et al. (2005) as in other studies (Butcher et al. 2014; Quicke et al. 2016). For the 28S gene, only confidently alignable positions were included in the analyses. Data were partitioned into the three COI codon positions and pairing and non-pairing bases of the RNA gene (Quicke et al. 2020, 2021; Shimbori et al. 2024). The concatenated data set was analyzed using the maximum likelihood program RAxML-NG (ver. 8.2.12, see https://github.com/stamatak/standard-RAxML; Kozlov et al. 2019) with the GTR+G model selected for all partitions.

Results

Genus *Rogas* Nees, 1818

Rogas Nees, 1818: 306 (type species: (designated by Curtis 1834): *Ichneumon testaceus* Fabricius, 1798 [nec *I. testaceus* Gmelin, 1790; = *Rogas luteus* Nees, 1834]).

Pelecystoma Wesmael, 1838: 91; Shenefelt 1975: 1206–1209; Tobias 1976: 89; Marsh 1979a: 178; Tobias 1986: 84–85 (included in *Rogas* auct). Syn. by van Achterberg 1982. Type species (designated by Foerster 1862): *Rogas luteus* Nees, 1834 [type lost]. Synonymy.

Rhogas Agassiz, 1846: 325 (invalid emendation).

Diagnosis. Antenna with more than 50 flagellomeres. Maxillary palpus segment 3 strongly enlarged and laterally flattened in both sexes (Fig. 1D,F), segment 4 distinctly expanded basally. Labial palpus segment 2 inflated. Propodeum with short mid-longitudinal carina medioanteriorly which divides to form a pair of near parallel submedial carinae. Hind wing veins 1rs-m and M joining at an acute angle, much less than 75°. Hind wing vein M 1.15–1.5 × longer than M+CU. Hind tibia with comb of modified setae distomedially (Fig. 2B). Hind tibial spurs straight and evenly setose. Tarsal claws with large, dark, rather square basal lobe. Metasomal tergite 1 approximately 1.2 × longer than posteriorly wide. Dorsope present, large and deep; dorsal carinae of metasomal tergite 1 remaining separate or joined to form point (Fig. 2E). Metasomal tergite 2 with wide polygonal midbasal area (Fig. 2F); midlongitudinal carina variably present. Metasomal tergites 2–5 with sharp lateral crease. Female hypopygium ventrally nearly straight and posteriorly truncate.

Rogas was redescribed and illustrated by van Achterberg (1991), reproduced and slightly modified by Chen and He (1997), and the holotype of *Rogas luteus* was illustrated by van Achterberg (1991). Chen and He (1997) provide a key to Old World species.

Rogas may be distinguished from both Old and New World *Triraphis* by its maxillary palpi having the third segment swollen and laterally flattened having the swollen third segment (Fig. 1D, F), the occipital carina being complete (although sometimes weak) ventrally and joining hypostomal carina (reduced ventrally, without ventral junction with hypostomal carina in *Triraphis*) (Fig. 1C) (Ratnasingham and Hebert 2013), and with claws which have a large, dark square (truncate) basal lobe (small, acute and pale in *Triraphis*) (Fig. 2C) (van Achterberg 1991; Chen and He 1997).

All reliable host records for *Rogas* are from Limacodidae caterpillars (Quicke and Shaw 2006). Published records from Zygaenidae result from failure to recognize *Triraphis* as a distinct genus (Quicke et al. 2003) and records from other families might result from misidentifications of *Aleiodes* species.

Rogas shimborii Quicke & Sharkey , sp. nov.

https://zoobank.org/16ccb84c-a585-455d-a31c-76521b7710f2

Type material. ***Holotype.*** Costa Rica • ♀; Area de Conservación Guanacaste, Guanacaste Province, Sector Pailas, Pailas Dos, 10.76°N, 85.334°W, 809 m, 2.viii.2018, leg. D. Janzen, W. Hallwachs, ecotone between lowland tropical dry forest and intermediate elevation rain forest, Malaise trap PL12-9); CNC (Specimen voucher: BIOUG58035-F04; BIN BOLD:AEF7075). ***Paratype*:** Costa Rica • 1♀; Area de Conservación Guanacaste, Guanacaste Province, Sector Pailas, Pailas Dos, 10.764°N, 85.333°W, 853 m, 25.vi.2020, leg. D. Janzen, W. Hallwachs, ecotone between lowland tropical dry forest and intermediate elevation rain forest, Malaise trap (PL12-6); CNC. (Specimen voucher: BIOUG63902-A02; BIN BOLD:AEF707).

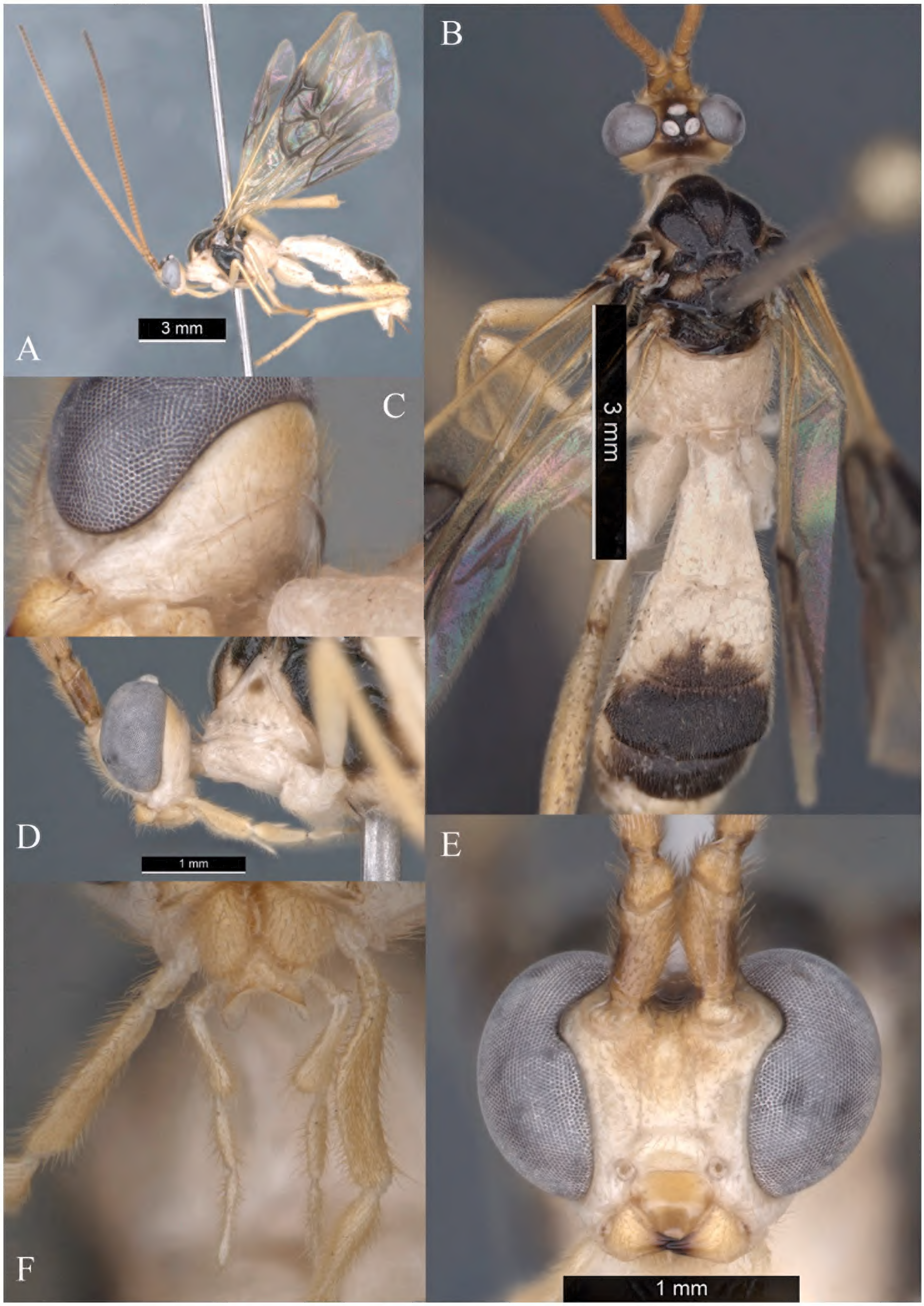

Figure 1. *Rogas shimborii* Quicke & Sharkey, sp. nov., holotype, female, specimen voucher BIOUG58035-F04 **A.** Habitus, lateral view; **B.** Habitus oblique dorsal view; **C.** Head, postero-ventral view showing connection between occipital and hypostomal carinae; **D.** Head and anterior mesosoma, lateral view; **E.** Head, anterior view; **F.** Labial palps, anterior view.

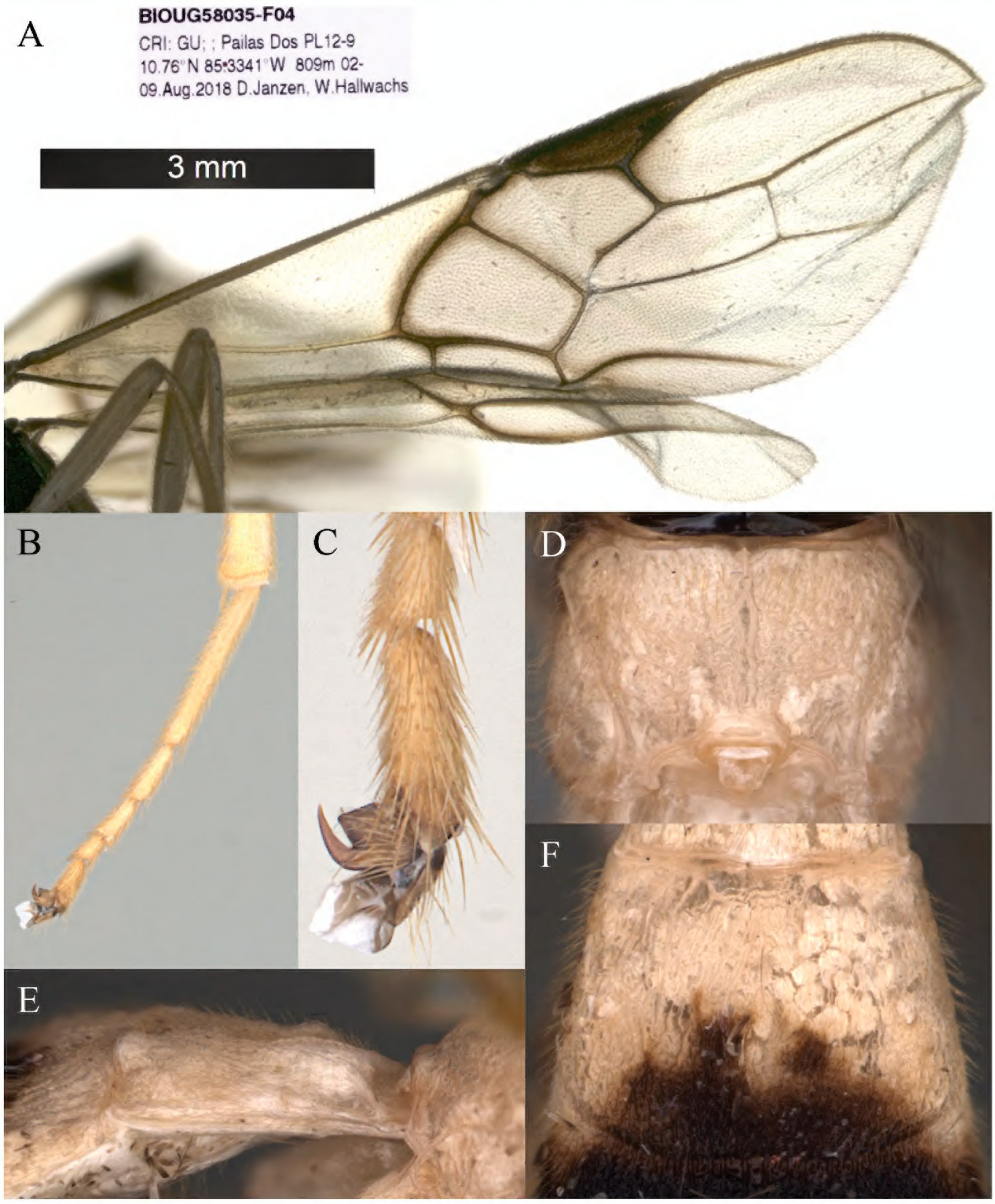

Figure 2. *Rogas shimborii* Quicke & Sharkey, sp. nov., holotype, female, specimen voucher BIOUG58035-F04; **A.** Forewing and part of hind wing (inset data label); **B.** Apex hind tibia and hind tarsus, inner view; **C.** Hind claw; **D.** Propodeum; **E.** Metasomal tergite 1 oblique lateral; **F.** Metasomal tergite 2.

Diagnostics. BOLD:AEF7075. Consensus barcode: TTTATATTTTTTATTTGGTATTTGAGCGGGGCTTTTAGGGCTATCTATAAGGTTAATTATTCGGTTAGAATTAAGTATACCTGGGAGGTTATTAGGTAATGATCAGATTTATAATGGAATAGTAACTGCACATGCATTTATCATAATTTTTTTTATAGTAATACCTATTATAATTGGGGGGTTTGGTAATTGATTAATTCCTTTAATATTAGGGGCTCCTGATAT-

GGCTTTCCCTCGTATAAATAATATAAGATTTT-
GATTGTTAATTCCGTCATTAATTTTATTATTATTA-
AGAGCTATTGTAAATGTAGGGGTTGGTACAG-
GTTGAACAATTTATCCTCCTTTATCTTCTTTA-
ATAGGGCATGGAGGGATATCTGTTGATTTAGC-
TATTTTTTCTTTACATTTAGCAGGTATCTCTTC-
TATTATAGGGGTTGTAAATTTTATTTCTA-
CAATTTTTAATATAAAGTTAATTTCTATT-
AGTCTAGATCAGATTAATTTATTTGTATG-
GTCTGTTTTAATTACTGCTATTTTATTATTAT-
TATCTTTACCTGTATTAGCGGGGGCCATTA-
CAATATTATTAACAGATCGTAATTTAAATA-
CAACTTTTTTTGATTTTTCAGGGGGGGGG-
GATCCTGTTTTATTTCAACATTTATTT

The new species may be distinguished from all other described species by its bicolorous (black and ivory-white metasoma (Fig. 1A, B); these are reddish-yellow, ochreous-yellow or brown in *R. luteus*, *R. oyeyamensis* (Watanabe, 1937), *R. roxana* (Telenga, 1941), *R. nigrovenosus* (Vojnovskaja-Krieger, 1935), *R. nigristigma* Chen & He, and *R. flavus* Chen & He, 1997 largely uniformly black in *R. nigricans* Chen & He, 1997, and *R. nigridorsum* Belokobylskij, 1996. The infuscate median transverse band of the forewing (Fig. 2A) is also unique to this species.

Etymology. Named in honor of Eduardo Mitio Shimbori in recognition of his contributions to Neotropical Rogadinae systematics.

Molecular results

Analysis of the concatenated two gene data set recovers the new species nested within the Old World *Rogas* representatives, and as sister group to *R. roxana* from the Russian Far East, though with low support (Fig. 3), and far removed from *Triraphis*. However, the latter genus was not recovered as monophyletic and its two clades were well separated. The larger clade was entirely comprised of Meso- and South American species whereas the smaller clade largely contained Old World species but also including *T. discoideus* (Cresson, 1869) from North America and one species, *T. robertomirandai* Sharkey, 2021, from Costa Rica.

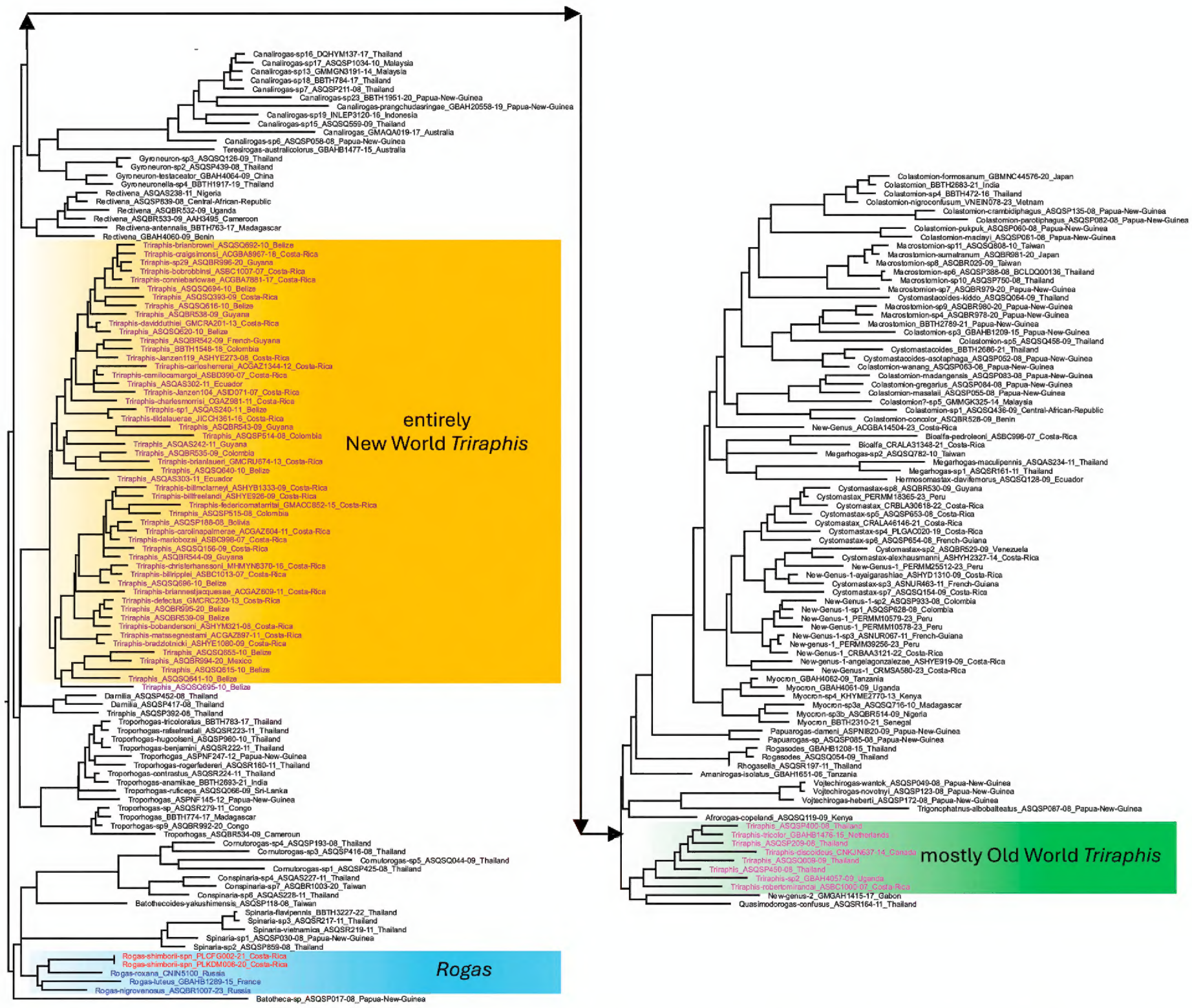

Figure 3. Maximum likelihood phylogenetic tree of the Rogadinae based on concatenated COI and 28S sequences.

Discussion

Superficially, *R. shimborii* sp. nov. quite closely resembles New World *Triraphis* whose members quite frequently have the veins and adjacent wing membrane in the middle part of the forewing, black or darkened (Valerio and Shaw 2015; Sharkey et al. 2021; Jasso-Martínez et al. 2024). In light of this discovery of a typical "true" *Rogas* species in the New World region, it seems prudent that future studies of *Triraphis* proceed carefully with the new knowledge that both genera occur in the Americas.

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